

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2005-108665

(43)Date of publication of application : 21.04.2005

(51)Int.Cl.

H05B 33/14
H05B 33/22

(21)Application number : 2003-341248

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(22)Date of filing : 30.09.2003

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(54) LIGHT-EMITTING DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a light-emitting device having good light-emitting efficiency and durability.

SOLUTION: The light-emitting device includes a hole transport layer, at least two layers of light-emitting layers with, and an electron transport layer between a pair of electrodes. All the light-emitting layers contain phosphorescence luminescent compounds and host compounds, respectively, and also, the density of the phosphorescence luminescent compound of the light-emitting layer at a cathode side is higher than that at an anode side in the light-emitting device.

LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[Field of the Invention]

[0001]

This invention relates to a light emitting device with good luminous efficiency and endurance.

[Background of the Invention]

[0002]

Generally, the light emitting device consists of counterelectrodes of the pair the luminous layer and this whose layer were pinched. When electric field are impressed between two electrodes, an electron is poured in from cathode and, as for luminescence, an electron hole is poured in from an anode plate. In case this electron and electron hole recombine in a luminous layer and an energy level returns from a conduction band to a valence band, it is the phenomenon which emits energy as a light.

[0003]

Although there is an organic light emitting device which used the organic compound for the luminous layer as such a light emitting device, for example, compared with fluorescence tubing, luminous efficiency is very low. Many of present organic light emitting devices using the fluorescence acquired from a singlet exciton, and using the phosphorescence obtained from a triplet exciton for improvement in luminous efficiency is examined. For example, the organic light emitting device of phosphorescence use using the phenyl pyridine complex of iridium is reported (for example, nonpatent literature 1 reference, patent reference 1 reference). According to these, the purport which shows one 2 to 3 times the luminous efficiency of this is reported to the organic light emitting device of the conventional fluorescence use.

However, the organic light emitting device of phosphorescence use has the bad endurance at the time of a drive for putting in practical use, and a light emitting device excellent in both luminous efficiency and endurance is desired strongly.

[Patent reference 1] The United States patent number No. 6303238 specification

[Nonpatent literature 1] Applied A FIJKUSU letter, 1999, 75 volumes, 4 pages

[Description of the Invention]

[Problem(s) to be Solved by the Invention]

[0004]

The purpose of this invention is to offer the light emitting device excellent in luminous efficiency and endurance.

[Means for Solving the Problem]

[0005]

According to this invention, the light emitting device of the following configuration is offered and the above-mentioned purpose of this invention is offered.

It is the light emitting device which has an electron hole transportation layer, a two-layer luminous layer, and an electronic transportation layer at least in inter-electrode [of <1> pair],

The light emitting device characterized by the luminous layer in an anode plate side being higher than the luminous layer to which the concentration of a phosphorescence luminescence compound has all luminous layers in a cathode side, respectively, including a phosphorescence luminescence compound and a host compound.

A light emitting device given in the above <1> whose concentration of the phosphorescence luminescence compound of <2> luminous layers is characterized by being below 20 mass % more than 0.01 mass % in each luminous layer.

A light emitting device the above <1> whose electronic transportation ingredient contained in <3> electronic

transportation layer is characterized by being the aromatic series heterocycle compound which has one or more hetero atoms in intramolecular, or given in <2>.

[Effect of the Invention]

[0006]

According to this invention, at least, by turning the concentration of the phosphorescence luminescence compound of a luminous layer to the luminous layer by the side of an anode plate, and making it high one by one from the luminous layer by the side of cathode, including the phosphorescence luminescence compound and host compound which are different from each other, the light emitting device which reconciled luminous efficiency and endurance is obtained, and each of a two-layer luminous layer can be provided with the same or the light emitting device of high brightness especially whose endurance improved sharply. The light emitting device of this invention can be used effective in the surface light source of a full color display, a back light, the source of the illumination light, etc., light source arrays, such as a printer, etc.

[Best Mode of Carrying Out the Invention]

[0007]

The light emitting device of this invention is a light emitting device which has the organic layer which contains an electron hole transportation layer, a two-layer luminous layer, and an electronic transportation layer in inter-electrode [of a pair] at least, and each luminous layer of all contains the same or the phosphorescence luminescence compound which is different from each other, and a host compound. And the luminous layer in an anode plate side is higher than the luminous layer which has the concentration of the phosphorescence luminescence compound of a luminous layer in a cathode side, i.e., the concentration of the phosphorescence luminescence compound of a luminous layer is a light emitting device increasing [from the luminous layer by the side of cathode] one by one towards the luminous layer by the side of an anode plate.

Here, saying "the concentration of the phosphorescence luminescence compound of a luminous layer is increasing one by one towards the luminous layer by the side of an anode plate from the luminous layer by the side of cathode" When there are three layers of luminous layers, the concentration of the phosphorescence luminescence compound of the luminous layer nearest to a cathode side is specifically the lowest. The concentration of the phosphorescence luminescence compound of the luminous layer nearest to an anode plate side is the highest, and the condition that there is concentration of the phosphorescence luminescence compound of the luminous layer located in the middle in the middle of both concentration is meant.

[0008]

Although a phosphorescence luminescence compound is a compound which can emit light from a triplet exciton and it is not limited especially, an alt.metal-ized metal complex or a porphyrin metal complex is desirable.

[0009]

An alt.metal-ized metal complex is the generic name of the compound group indicated by Akio Yamamoto work "organic metal chemistry-foundation and application" 150 page, 232 pages, Shokabo Publishing Co., Ltd. (1982 issue), the "Photochemistry and Photophysics of Coordination Compounds" 71-77 page written by H.Yersin, 135-146 pages and Springer-Verlag (1987 issue), etc. [-] Said organic layer containing an alt.metal-ized metal complex is advantageous at the point of excelling in luminous efficiency by high brightness.

[0010]

Although there are various things and it is indicated by the above-mentioned reference as a ligand which forms an alt.metal-ized metal complex, as a ligand desirable also in it, they are 2-phenyl pyridine derivative, 7, 8-benzoquinoline derivative, 2-(2-thienyl) pyridine derivative, 2-(1-naphthyl) pyridine derivative, and 2-phenyl quinoline **.

A conductor etc. is mentioned. These derivatives may have a substituent if needed.

The alt.metal-ized metal complex may have other ligands other than the above-mentioned ligand.

[0011]

The alt.metal-ized metal complex used by this invention Inorg.Chem., 1991, No. 30, and 1685 pages, This 1988, No. 27, 3464 pages, this 1994, No. 33, and 545 pages, Inorg.Chim.Acta, 1991, No. 181, and 245 pages, J. -- Organomet.Chem., 1987, No. 335, 293 pages, J.Am.Chem.Soc., 1985, No. 107, and 1431 pages etc. -- it is compoundable by various well-known technique.

The compound which emits light from a triplet exciton can be used as a phosphorescence luminescence compound in this invention in an alt.metal-ized metal complex.

[0012]

Moreover, in a porphyrin metal complex, a porphyrin platinum complex is desirable.

A phosphorescence luminescence compound may be used by the one-sort independent, and may use two or more sorts together.

[0013]

If it is the compound which can carry out energy transfer of the exciton energy to luminescent material as a host compound, there will be especially no limit. According to the purpose, it can choose suitably. Specifically A carbazole derivative, A triazole derivative, an oxazole derivative, an OKISA diazole derivative, An imidazole derivative, the poly aryl alkane derivative, a pyrazoline derivative, A pyrazolone derivative, a phenylenediamine derivative, an arylamine derivative, an amino permutation chalcone derivative, a styryl anthracene derivative, and full -- me -- non -- a derivative -- A hydrazone derivative, a stilbene derivative, a silazane derivative, an aromatic series tertiary-amine compound, A styryl amine compound, an aromatic series dimethylidene system compound, a porphyrin system compound, An anthra quinodimethan derivative, an anthrone derivative, a diphenyl quinone derivative, A thiopyran dioxide derivative, a carbodiimide derivative, a full ORENIRIDEN methane derivative, Heterocycle tetracarboxylic acid anhydrides, such as a JISUCHIRIRU pyrazine derivative and naphthalene perylene, The metal complex and metal phthalocyanine of a phthalocyanine derivative and an eight-quinolinol derivative, The various metal complex polysilane system compounds represented by the metal complex which makes benzooxazole and benzothiazole a ligand, The Pori (N-vinylcarbazole) derivative, an aniline system copolymer, thiophene oligomer, High molecular compounds, such as conductive polymer oligomer, such as the poly thiophene, the poly thiophene derivative, a polyphenylene derivative, a polyphenylene vinylene derivative, and the poly fluorene derivative, etc. are mentioned. These host compounds may be used by the one-sort independent, and may use two or more sorts together.

[0014]

Although especially the number of layers of a luminous layer is not limited, on component creation, more than two-layer, 20 or less layers are desirable, more than two-layer, ten or less layers are five or less layers more than two-layer more desirable still more preferably, and it is three or more-layer five or less layers especially preferably.

[0015]

As the light emitting device of this invention was mentioned already, the concentration of the phosphorescence luminescence compound of a luminous layer is increasing one by one towards the luminous layer by the side of an anode plate from the luminous layer by the side of cathode.

The case where the number of luminous layers is five is mentioned as an example, and is explained. as the component configuration in this case -- for example, anode plate / electron hole transportation layer / 1st luminous layer / 2nd luminous layer/-- the /4th luminous layer /, the 5th luminous layer / electronic transportation layer / electronic injection layer / cathode is mentioned the 3rd luminous layer. In this component configuration, the phosphorescence luminescence compound concentration of the 1st luminous layer which is a luminous layer by the side of an anode plate most 20 mass %, After that, one by one, by 15 mass % and the 3rd luminous layer, the concentration of the phosphorescence luminescence compound in a luminous layer can be turned to the luminous layer by the side of an anode plate, and can be made high from the luminous layer by the side of cathode at the 2nd luminous layer by considering as 5 mass % in 10 mass % and the 4th luminous layer, and considering as 0.01 mass % in the 5th luminous layer. That is, the light emitting device of this invention with the luminous layer higher than the luminous layer which has the concentration of the phosphorescence luminescence compound of a luminous layer in a cathode side in an anode plate side can be created.

[0016]

It is desirable still more desirable that any luminous layer is below 20 mass % more than 0.01 mass %, and the concentration of the phosphorescence luminescence compound of a luminous layer is below 10 mass % more than 0.01 mass %. If the concentration of a phosphorescence luminescence compound becomes large rather than this, luminous efficiency will fall by concentration quenching. If the concentration of a phosphorescence compound becomes small rather than this, the energy transfer probability from a host ingredient to a phosphorescence luminescence ingredient will fall, and luminous efficiency will fall.

Moreover, below 20 mass % of the concentration difference of the phosphorescence luminescence compound of an adjoining luminous layer is desirable more than 1 mass %, it is more desirable more than 1 mass %, is still more desirable more than 1 mass %, and is desirable more than 2 mass %. [of below 5 mass % / especially] [of below 5 mass %] [of 10 mass %]

[0017]

Each thickness of a luminous layer has desirable 1-50nm, and its 2-40nm is more desirable. When the thickness of each luminous layer exceeds 50nm, driver voltage may go up, and when it is less than 1nm, this light emitting device may short-circuit.

[0018]

By considering as the component configuration of this invention, improvement in luminous efficiency and improvement in endurance can be attained. Although the reason is not clear, by making it the above-mentioned configuration, the rate that an electron hole runs through the inside of a luminous layer decreases, and it thinks because a carrier is excited effectively and it can use for generation.

Furthermore, by turning the concentration of the phosphorescence luminescence compound within each luminous layer to an anode plate side, and making it high one by one from a cathode side, by making concentration high by the electron hole transportation layer side, impregnation of an electron hole is helped and it is thought by making concentration low by the electronic transportation layer side that the thrust omission to the electronic transportation layer of an electron hole can be prevented.

[0019]

In the luminous layer of this invention, an electron hole transportation ingredient and an electronic transportation ingredient may be added if needed.

[0020]

the electron hole transportation ingredient added by the luminous layer if needed -- low-molecular electron hole transportation material and macromolecule electron hole transportation material -- all can be used, for example, the following ingredients can be mentioned.

A carbazole derivative, a triazole derivative, an oxazole derivative, an OKISA diazole derivative, An imidazole derivative, the poly aryl alkane derivative, a pyrazoline derivative, A pyrazolone derivative, a phenylenediamine derivative, an arylamine derivative, an amino permutation chalcone derivative, a styryl anthracene derivative, and full - me -- non -- a derivative -- A hydrazone derivative, a stilbene derivative, a silazane derivative, an aromatic series tertiary-amine compound, A styryl amine compound, an aromatic series dimethylidene system compound, a porphyrin system compound, A polysilane system compound, the Pori (N-vinylcarbazole) derivative, an aniline system copolymer, High molecular compounds, such as conductive polymer oligomer, such as thiophene oligomer and the poly thiophene, the poly thiophene derivative, a polyphenylene derivative, a polyphenylene vinylene derivative, and the poly fluorene derivative, etc. are mentioned. These may be used by the one-sort independent and may use two or more sorts together.

[0021]

It is not restricted especially as an electronic transportation ingredient added by the luminous layer if needed, for example, the following ingredients can be mentioned.

A triazole derivative, an oxazole derivative, an OKISA diazole derivative, full -- me -- non -- a derivative, an anthra quinodimethan derivative, and an anthrone derivative -- A diphenyl quinone derivative, a thiopyran dioxide derivative, a carbodiimide derivative, Heterocycle tetracarboxylic acid anhydrides, such as a full ORENIRIDEN methane derivative, a JISUCHIRIRU pyrazine derivative, and naphthalene perylene, The metal complex and metal phthalocyanine of a phthalocyanine derivative and an eight-quinolinol derivative, The various metal complexes represented by the metal complex which makes benzooxazole and benzothiazole a ligand, High molecular compounds, such as conductive polymer oligomer, such as an aniline system copolymer, thiophene oligomer, and the poly thiophene, the poly thiophene derivative, a polyphenylene derivative, a polyphenylene vinylene derivative, and the poly fluorene derivative, can be mentioned. These may be used by the one-sort independent and may use two or more sorts together.

[0022]

each luminous layer -- the wet producing-film methods, such as the dry type producing-film methods, such as vacuum deposition and a spatter, dipping, a spin coat method, a dip coating method, the cast method, the die coat method, the roll coat method, the bar coat method, and the gravure coat method, -- a film can be suitably produced by all.

[0023]

The light emitting device of this invention is explained below at a detail.

- Organic layer -

-- Configuration of an organic layer --

although there is especially no limit and it can choose suitably as a formation location in the light emitting device of an

organic layer according to the application of this light emitting device, and the purpose -- an anode plate top -- or being formed on cathode is desirable. In this case, this organic layer is formed in the front face or the whole surface on an anode plate or cathode.

About the configuration of an organic layer, magnitude, and thickness, there is especially no limit and it can be suitably chosen according to the purpose.

[0024]

As concrete lamination of the light emitting device of this invention, an anode plate / an electron hole transportation layer / two or more luminous layers / electronic transportation layer / cathode, an anode plate / electron hole transportation layer / two or more luminous layers / electronic transportation layer / electronic injection layer / cathode, an anode plate / hole injection layer / electron hole transportation layer / two or more luminous layers / electronic transportation layer / cathode, an anode plate / hole injection layer / electron hole transportation layer / two or more luminous layers / electronic transportation layer / electronic injection layer / cathode, etc. are mentioned including an organic layer.

Also in any, a phosphorescence luminescence compound contains in a luminous layer, and luminescence is usually taken out from a transparent electrode **** anode plate.

[0025]

-- Electronic transportation layer --

In this invention, the electronic transportation layer containing an electronic transportation ingredient can be prepared. It will not be restricted, if it has the function to convey an electron as an electronic transportation ingredient, or the function which carries out the obstruction of the electron hole poured in from the anode plate and is, and electronic transportation material can be used suitably.

The aromatic series heterocycle compound which has one or more hetero elements in intramolecular especially in this invention is desirable.

[0026]

As for the electronic transportation ingredient used by this invention, it is desirable to have an azole frame also in the aromatic series heterocycle compound which has one or more hetero elements in intramolecular. The compound which has an azole frame may be a compound which has atoms other than a carbon atom and a hydrogen atom in [two or more] a basic frame, and may be a monocycle or a condensed ring. It is the aromatic series heterocycle which has two or more atoms preferably chosen from N, O, and S atom as a heterocycle frame, and has an at least 1N atom in a frame still more preferably, and is the aromatic series heterocycle which has N atom in [two or more] a frame preferably especially. Moreover, a hetero atom may be in a condensation location, or may be in a non-condensation location.

[0027]

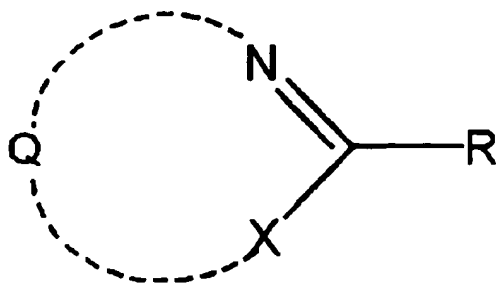
As a compound which has a heterocycle frame containing two or more hetero atoms For example, a pyrazole, an imidazole, pyrazine, a pyrimidine, indazole, A pudding, phthalazine, a NAFUCHI lysine, quinoxaline, quinazoline, cinnoline, A pteridine, peri MIJIN, a phenanthroline, a pyrrolo imidazole, Pyrrolo triazole, a pyrazolo imidazole, pyrazolo triazole, A pyrazolo pyrimidine, pyrazolo triazine, an imidazo imidazole, Imidazo pyridazine, an imidazo pyridine, imidazo pyrazine, a triazolo pyridine, Benzimidazole, a naphth imidazole, benzooxazole, naphth oxazole, Benzothiazole, a naphth thiazole, benzotriazol, a TETORAZA indene, Triazine etc. is mentioned. Preferably Imidazo pyridazine, an imidazo pyridine, Imidazo pyrazine, benzimidazole, a naphth imidazole, benzooxazole, It is the compound which has the compound or triazine frame which has condensation azole frames, such as naphth oxazole, benzothiazole, and a naphth thiazole, and is an imidazo pyridine especially preferably.

[0028]

It is the compound expressed with the following general formula (1) preferably as a compound which has an azole frame.

[0029]

[Formula 1]



[0030]

R expresses a hydrogen atom or a substituent among the above-mentioned general formula (1). As a substituent, aryl groups, such as a phenyl group, a naphthyl group, etc. which may have alkyl groups, such as a methyl group, an ethyl group, i-propyl group, and n-propyl group, and a substituent, are mentioned.

X expresses O, S, or N-Ra (Ra expresses a hydrogen atom, an aliphatic hydrocarbon radical (for example, a methyl group, an ethyl group, i-propyl group, n-propyl group), an aryl group (for example, a phenyl group, a naphthyl group, an anthranil), or a heterocycle radical (for example, a thienyl group, a pyridyl radical)).

Q expresses an atomic group required to combine with N and X and form heterocycle.

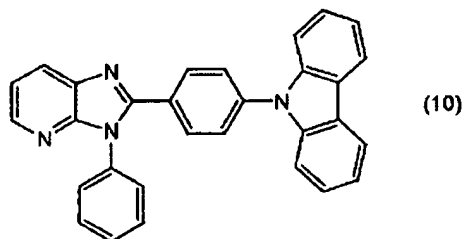
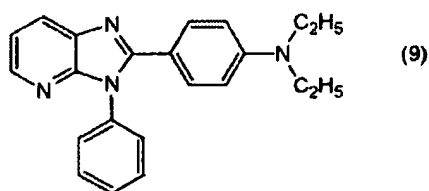
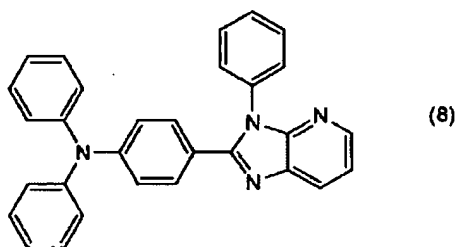
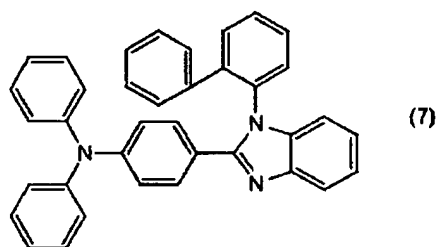
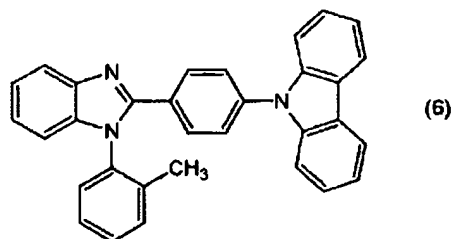
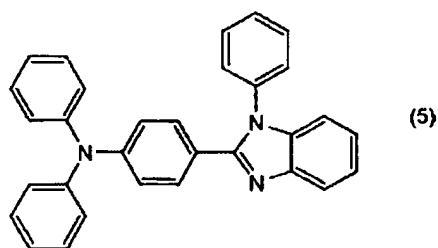
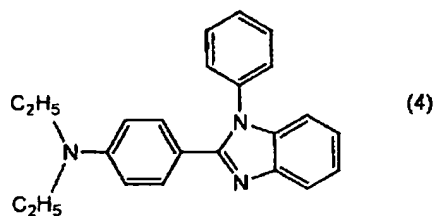
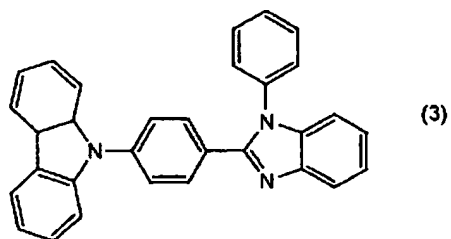
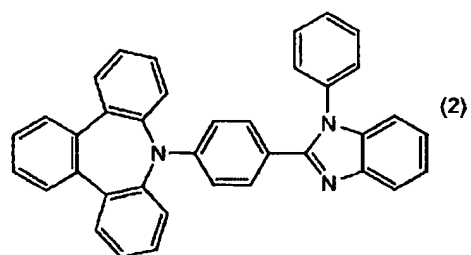
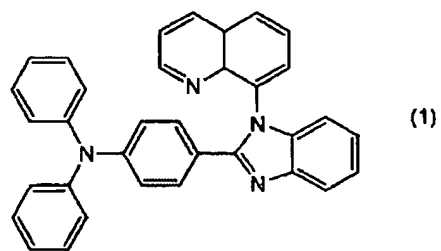
Moreover, R, and X, R and Q may form a ring unitedly, when possible.

[0031]

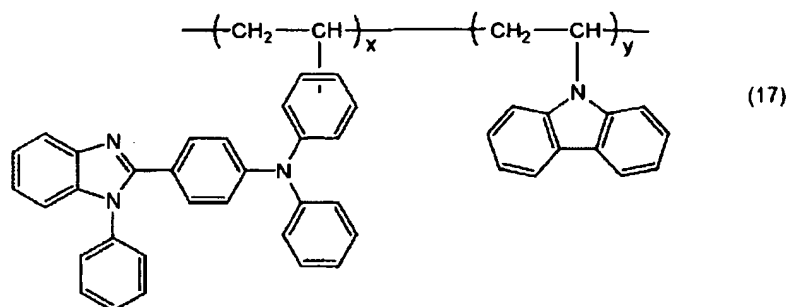
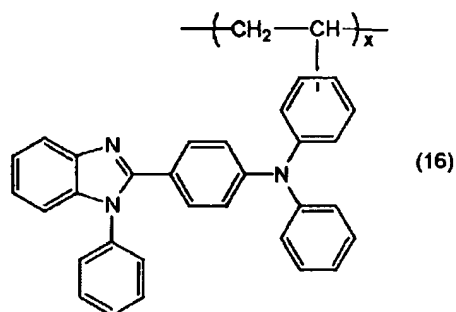
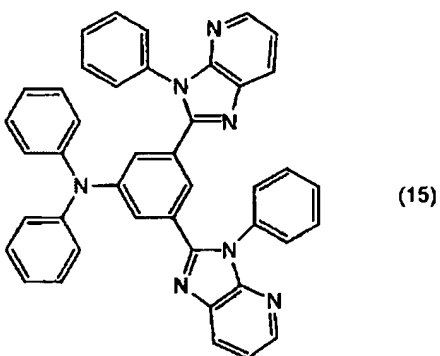
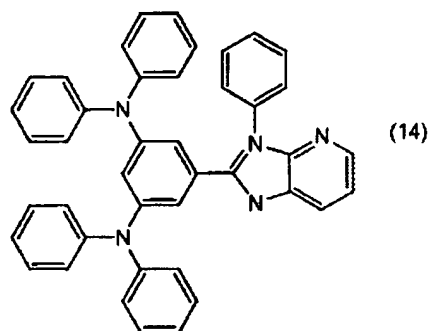
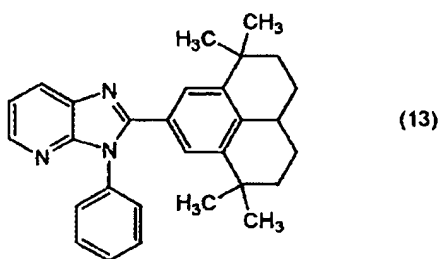
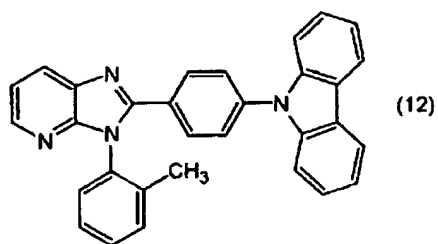
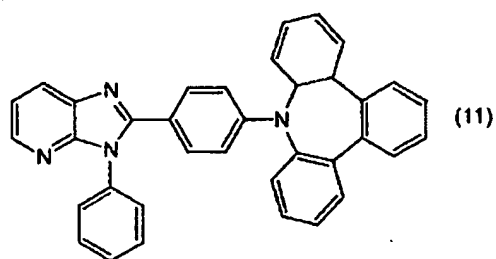
Although the example of the electronic transportation ingredient used for below by this invention is shown, this invention is not limited to these.

[0032]

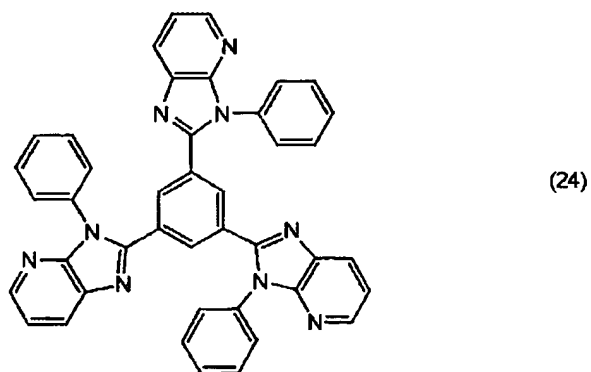
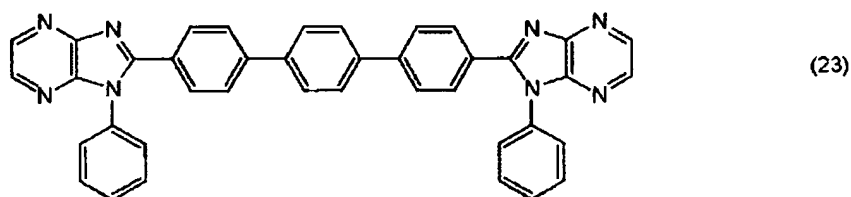
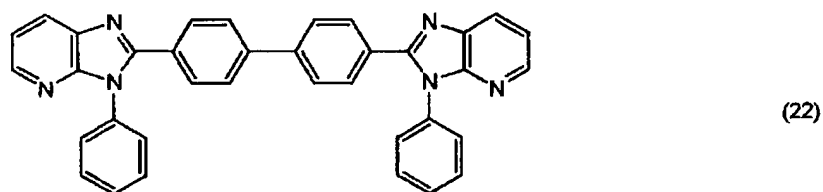
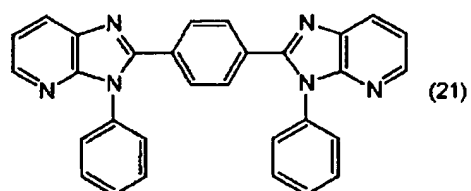
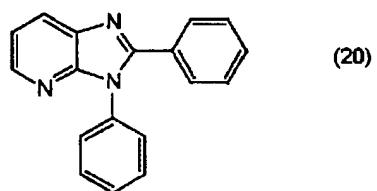
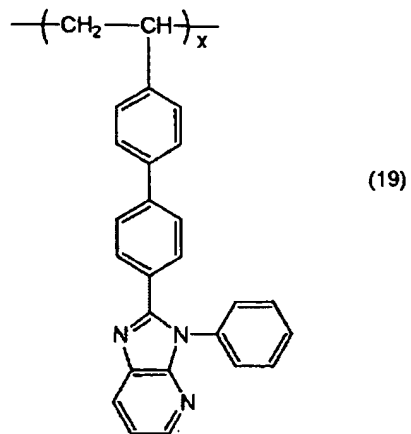
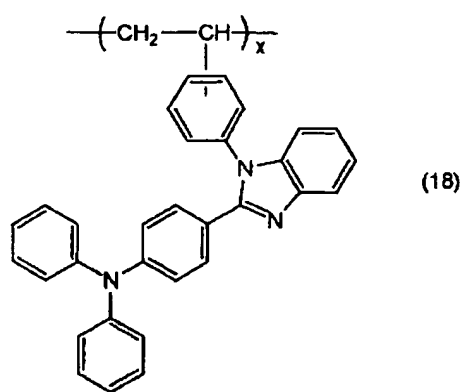
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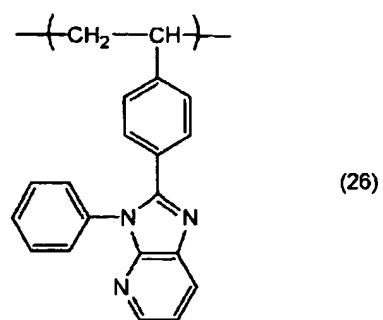
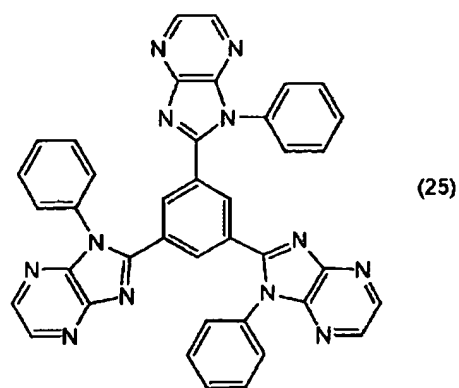
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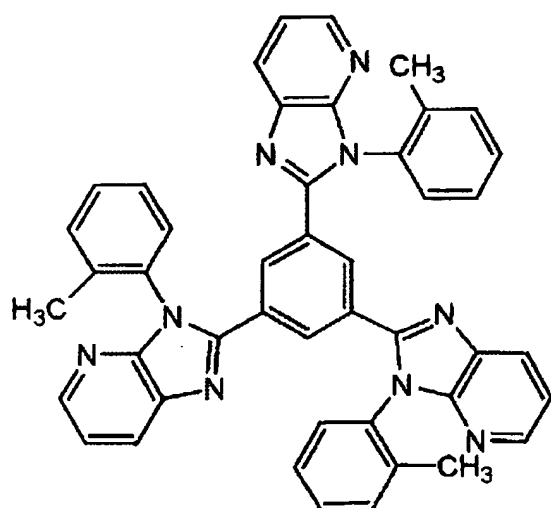
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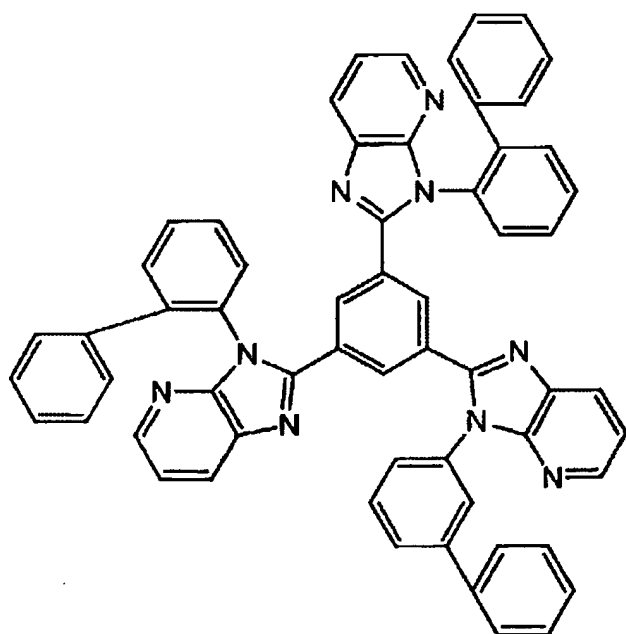
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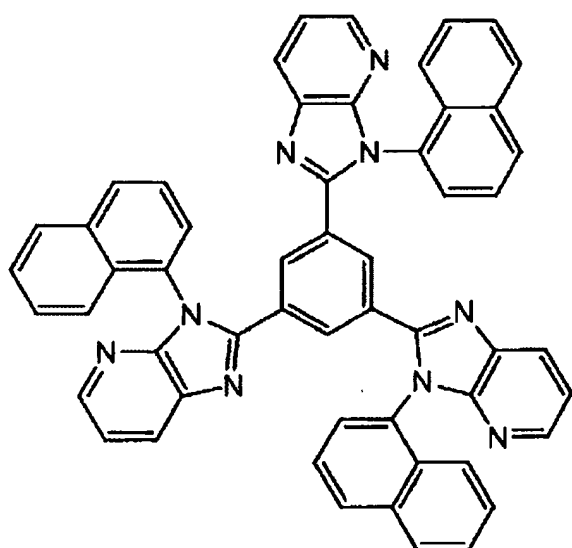
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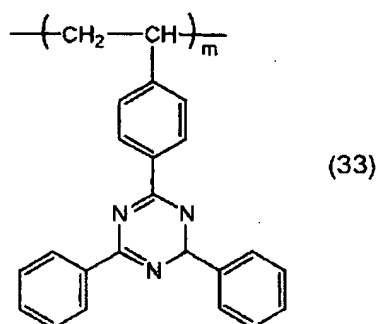
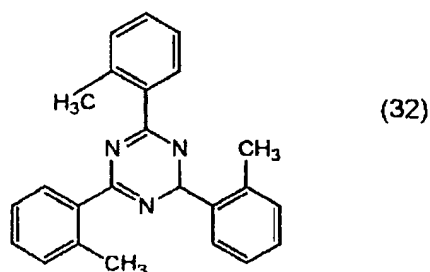
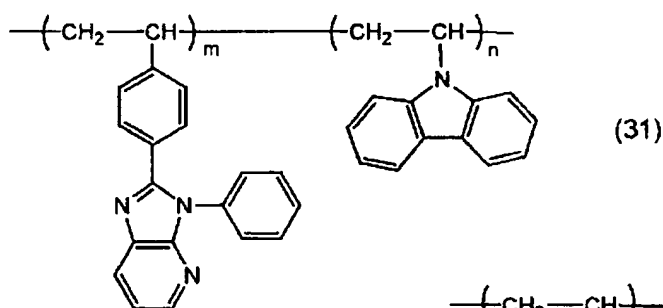
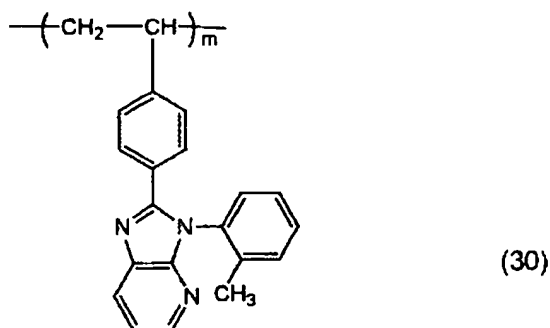
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[0037]

[Formula 7]



[0038]

The compound expressed with the general formula (1) used by this invention is JP,44-23025,B, a 48-8842 official report, JP,53-6331,A, JP,10-92578,A, a U.S. Pat. No. 3,449,255 number specification, this No. 5,766,779 specification, J.Am.Chem.Soc., 94 and 2414 (1972), Helv.Chim.Acta, 63,413 (1980), and Liebigs. It is compoundable by carrying out the approach of a publication to reference Ann.Chem., 1423 (1982), etc.

[0039]

Luminous efficiency and endurance can be made to improve further further by using it for the electronic transportation layer of this invention, using as an electronic transportation ingredient the compound expressed with these general formulas (1).

[0040]

As thickness of an electronic transportation layer, in order to avoid the rise of driver voltage, and the short circuit of a light emitting device, 10-200nm is desirable and 20-80nm is more desirable.

[0041]

In this invention, an electron hole block layer can be prepared between a luminous layer and an electronic transportation layer. An electron hole block layer is a layer which controls that an electron hole runs in a cathode side from a luminous layer, it is electronic transportability and the big ingredient of ionization potential can be used. These can be suitably chosen from electronic transportation material.

[0042]

this invention -- if it is, an electronic injection layer can be formed between an electronic transportation layer and cathode.

An electronic injection layer is a layer which make an electron easy to inject into an electronic transportation layer from cathode, and insulating metallic oxides, such as alkali-metal salts, such as lithium salt, such as lithium fluoride, a lithium chloride, and a lithium bromide, a sodium fluoride, a sodium chloride, and cesium fluoride, lithium oxide, an aluminum oxide, indium oxide, and a magnesium oxide, etc. can specifically be used suitably. The thickness of an electronic injection layer is 0.1-5nm.

[0043]

-- Electron hole transportation layer --

The electron hole transportation layer which contains electron hole transportation material if needed in this invention can be prepared.

It will not be restricted, if it has the function to convey an electron hole as electron hole transportation material, or the function which carries out the obstruction of the electron poured in from cathode and is, and electron hole transportation material can be used suitably.

As thickness of an electron hole transportation layer, in order to avoid the rise of driver voltage, and the short circuit of a light emitting device, 10-200nm is desirable and 20-80nm is more desirable.

[0044]

this invention -- if it is, a hole injection layer can be formed between an electron hole transportation layer and an anode plate.

A hole injection layer is a layer which make an electron hole easy to inject into an electron hole transportation layer from an anode plate, and the small ingredient of ionization potential is specifically ***** for suitable in electron hole transportation material. For example, a phthalocyanine compound, a porphyrin compound, a starburst mold thoria reel amine compound, etc. can be mentioned, and can be used suitably.

The thickness of a hole injection layer is 1-30nm.

[0045]

-- Formation of an organic layer --

organic layers, such as the above-mentioned electronic transportation layer and an electron hole transportation layer, -- the wet producing-film methods, such as the dry type producing-film methods, such as vacuum deposition and a sputter, dipping, a spin coat method, a dip coating method, the cast method, the die coat method, the roll coat method, the bar coat method, and the gravure coat method, -- a film can be suitably produced by all.

In addition, selection of the class of these producing-film methods can be suitably performed according to the ingredient of this organic layer.

[0046]

Although it can dry suitably and there is especially no limit as conditions for this desiccation after producing a film when a film is produced by the wet producing-film method, the temperature of the range which the layer which carried out spreading formation does not damage etc. is employable.

[0047]

- Base material -

As an ingredient of a base material, the ingredient which does not make moisture penetrate, or the very low ingredient of moisture permeability is desirable. Moreover, the ingredient to which light emitted from an organic layer is not carried out [attenuation / dispersion thru/or] is desirable. For example, inorganic materials, such as YSZ (zirconia stabilization yttrium) and glass, Polyester, such as polyethylene terephthalate, polybutylene terephthalate, and polyethylenenaphthalate, Organic materials, such as synthetic resin, such as polystyrene, a polycarbonate, polyether sulphone, polyarylate, allyl compound diethylene glycol carbonate, polyimide, the poly cycloolefin, norbornene resin, and Pori (chlorotrifluoroethylene), etc. are mentioned. In the case of an organic material, it is desirable to excel in thermal resistance, dimensional stability, solvent resistance, electric insulation, workability, low permeability, low hygroscopicity, etc. When the ingredient of a transparent electrode is the tin oxide indium (ITO) suitably used as an ingredient of this transparent electrode also in these, an ingredient with the small difference of a lattice constant with this tin oxide indium (ITO) is desirable. These ingredients may be used by the one-sort independent, and may use two or more sorts together.

[0048]

About the configuration of a base material, structure, and magnitude, there is especially no limit and it can be suitably chosen according to the application of a light emitting device, the purpose, etc. Generally, as a configuration, it is tabular. As structure, you may be monolayer structure, and may be a laminated structure, and it may be formed by the single member, and may be formed by two or more members.

[0049]

It is desirable that a base material may be transparent and colorless, and it is transparent and colorless at the point to which dispersion or attenuation does not carry out light emitted from a luminous layer although you may be colored transparence.

[0050]

To a base material, it is desirable to prepare a moisture permeation prevention layer (gas barrier layer) in the front face or rear face (transparent electrode side).

As an ingredient of a moisture permeation prevention layer (gas barrier layer), inorganic substances, such as silicon nitride and oxidation silicon, are used suitably. This moisture permeation prevention layer (gas barrier layer) can be formed for example, by a RF-sputtering method etc.

A rebound ace court layer, an under coat layer, etc. may be further prepared in a base material if needed.

[0051]

- Anode plate -

That what is necessary is just to usually have the function as an anode plate which supplies an electron hole to an organic layer as an anode plate, there is especially no limit about the configuration, structure, and magnitude, and it can choose suitably from well-known electrodes according to the application of a light emitting device, and the purpose.

[0052]

As an ingredient of an anode plate, for example, a metal, an alloy, a metallic oxide, organic conductivity compounds, or such mixture are mentioned suitably, and an ingredient 4.0eV or more has a desirable work function. the tin oxide (ATO --) which doped antimony, a fluorine, etc. as an example FTO, tin oxide, a zinc oxide, indium oxide, indium oxide tin (ITO), Semiconductance metallic oxides, such as a zinc oxide indium (IZO), gold, silver, chromium, Organic conductivity ingredients, such as inorganic conductivity matter, such as mixture of these metals and conductive metallic oxide or laminated material, copper iodide, and copper sulfide, the poly aniline, the poly thiophene, and polypyrrole, the laminated material of these and ITO, etc. are mentioned to metals, such as nickel, and a pan.

[0053]

An anode plate can be formed on a substrate according to the approach suitably chosen in consideration of fitness with the above-mentioned ingredient from chemical methods, such as physical methods, such as wet methods, such as a printing method and a coating method, vacuum evaporation technique, the sputtering method, and the ion plating method, CVD, and a plasma-CVD method, etc. For example, as an ingredient of an anode plate, when choosing ITO, formation of this anode plate can be performed according to a direct current or a high frequency spatter, vacuum evaporation technique, the ion plating method, etc. Moreover, when choosing an organic conductivity compound as an ingredient of an anode plate, it can carry out according to the wet producing-film method.

[0054]

Although there is especially no limit and it can choose suitably according to the application of this light emitting device, and the purpose as a formation location of the anode plate in the light emitting device of this invention, being formed on a substrate is desirable. in this case, also in the substrate, a front face boils all, it may be formed and this anode plate may be formed in that part.

[0055]

In addition, the chemical etching by photolithography etc. may perform patterning of an anode plate, physical etching by laser etc. may perform it, and it may carry out vacuum deposition, a spatter, etc. in piles, may perform a mask, and may perform it by the lift-off method or print processes.

[0056]

Although it can choose suitably as thickness of an anode plate according to the above-mentioned ingredient and cannot generally specify, it is usually 10nm - 50 micrometers, and 50nm - 20 micrometers are desirable.

As resistance of an anode plate, below 103ohms / ** are desirable, and below 102ohms / ** are more desirable.

In order to take out luminescence from this anode plate side, a transparent thing is desirable, and as the permeability, 60% or more of an anode plate is desirable, and is more desirable. [70% or more of] This permeability can be measured according to the well-known approach which used the spectrophotometer. Moreover, the anode plate may be

transparent and colorless in this case, or you may be colored transparence,

[0057]

In addition, about an anode plate, the Sawada ***** "new expansion of transparent electrode film" CMC ** (1999) has a detailed explanation, and these can be applied to this invention. When using a heat-resistant low plastic base material, the anode plate which used ITO or IZO and produced the film at low temperature 150 degrees C or less is desirable.

[0058]

- Cathode -

That what is necessary is just to usually have as cathode the function as cathode to inject an electron into an organic layer, there is especially no limit about the configuration, structure, and magnitude, and it can choose suitably from well-known electrodes according to the application of a light emitting device, and the purpose.

[0059]

As an ingredient of cathode, for example, a metal, an alloy, a metallic oxide, electrical conductivity compounds, such mixture, etc. are mentioned, and a thing 4.5eV or less has a desirable work function. As an example, rare earth metals, such as alkali metal (for example, Li, Na, K, Cs, etc.), alkaline earth metal (for example, Mg, calcium, etc.), gold, silver, lead, aluminum, a sodium-potassium alloy, a lithium-aluminium alloy, a magnesium-silver alloy, an indium, and an ytterbium, etc. are mentioned. Although these may be used by the one-sort independent, they can use two or more sorts together suitably from a viewpoint which reconciles stability and electron injection nature.

[0060]

Also in these, in respect of electron injection nature, alkali metal and an alkalinity metal are desirable and the ingredient which makes aluminum a subject in that it excels in preservation stability is desirable.

The ingredient which makes aluminum a subject means an alloy or mixture with aluminum independence or aluminum, 0.01 - 10% of the weight of alkali metal, or an alkaline earth metal (for example, a lithium-aluminium alloy, a magnesium-aluminium alloy, etc.).

[0061]

In addition, the ingredient of cathode is explained by JP,2-15595,A and JP,5-121172,A in full detail.

[0062]

There is no method of forming cathode and it can perform especially a limit according to a well-known approach. For example, it can form according to the approach suitably chosen in consideration of fitness with said ingredient from chemical methods, such as physical methods, such as wet methods, such as a printing method and a coating method, vacuum evaporation technique, the sputtering method, and the ion plating method, CVD, and a plasma-CVD method, etc. For example, as an ingredient of cathode, when choosing a metal etc., its one sort or two sorts or more can be performed to coincidence or sequential according to a spatter etc.

[0063]

In addition, the chemical etching by photolithography etc. may perform patterning of cathode, physical etching by laser etc. may perform it, and it may carry out vacuum deposition, a spatter, etc. in piles, may perform a mask, and may perform it by the lift-off method or print processes.

[0064]

Although there is especially no limit and it can choose suitably as a formation location in the luminescence light emitting device of cathode according to the application of this light emitting device, and the purpose, being formed on an organic layer is desirable. In this case, this cathode may be formed in all on an organic layer, and may be formed in that part.

Moreover, the dielectric layer by the fluoride of alkali metal or alkaline earth metal etc. may be inserted by the thickness of 0.1-5nm between cathode and an organic layer.

In addition, this dielectric layer can be formed by vacuum evaporation technique, the sputtering method, the ion plating method, etc.

[0065]

Although it can choose suitably as thickness of cathode according to an ingredient and cannot generally specify, it is usually 10nm - 5 micrometers, and 50nm - 1 micrometer is desirable.

Cathode may be transparent and may be opaque. In addition, transparent cathode can produce the ingredient of cathode thinly in thickness of 1-10nm, and can form it by carrying out the laminating of the conductive ingredient with said still more transparent ITO, IZO, etc.

[0066]

- Other layers -

As other layers, there is especially no limit, and it can be suitably chosen according to the purpose, for example, a protective layer etc. is mentioned.

As a protective layer, the thing of a publication is suitably mentioned to JP,7-85974,A, a 7-192866 official report, a 8-22891 official report, a 10-275682 official report, a 10-106746 official report, etc., for example.

In the luminescence layered product which consists of a base material, an anode plate, an organic layer, and cathode, a protective layer is formed on this cathode, when the laminating of a base material, an anode plate, an organic layer, and the cathode is carried out to this order in that outermost surface, and when the laminating of a base material, cathode, an organic layer, and the anode plate is carried out to this order, it is formed on this anode plate.

About the configuration of a protective layer, magnitude, and thickness, it can choose suitably, as the ingredient, if it has the function which controls making what may degrade light emitting devices, such as moisture and oxygen, invade thru/or penetrate in this light emitting device, there will be especially no limit, for example, oxidation silicon, a silicon dioxide, a germanium dioxide, diacid-ized germanium, etc. are mentioned.

[0067]

As the formation approach of a protective layer, there is especially no limitation, for example, a vacuum deposition method, the sputtering method, a reactive sputtering method, the molecule SENEPI taxi method, the ionized cluster beam method, the ion plating method, a plasma polymerization method, a plasma-CVD method, a laser CVD method, a heat CVD method, a coating method, etc. are mentioned.

[0068]

Furthermore, in this invention, it is the purpose which prevents the invasion of the moisture to each class, or oxygen in a luminescence layered product, and it is also desirable to prepare a closure layer.

The copolymer which contains tetrafluoroethylene and at least one sort of comonomers as an ingredient of a closure layer, for example, The fluorine-containing copolymer which has cyclic structure in a copolymerization principal chain, polyethylene, polypropylene, Polymethylmethacrylate, polyimide, polyurea, polytetrafluoroethylene, Polychlorotrifluoroethylene resin, poly dichlorodifluoroethene, Two or more sorts of copolymers chosen from chlorotrifluoroethylene and dichlorodifluoroethene, The absorptivity matter of 1% or more of water absorption, the dampproof matter of 0.1% or less of water absorption, In, Metals, such as Sn, Pb, Au, Cu, Ag, aluminum, Tl, and nickel, MgO, SiO, SiO₂, aluminum 2O₃, GeO, NiO, CaO, BaO, The metallic oxide of Fe 2O₃, Y₂O₃, and TiO₂ grade, MgF₂, LiF, The thing which made liquefied fluorination carbon, such as AlF₃, a metal fluoride of CaF₂ grade, a perfluoro alkane, a perfluoro amine, and the perfluoro ether, and liquefied fluorination carbon distribute the adsorbent which adsorbs moisture and oxygen is mentioned.

[0069]

The light emitting device of this invention can obtain luminescence by impressing a direct-current (alternating current component also being included if needed) electrical potential difference (usually 2 volts - 40 volts) or a direct current between an anode plate and cathode.

The approach of a publication can be used for JP,2-148687,A, a 6-301355 official report, a 5-29080 official report, a 7-134558 official report, a 8-234685 official report, this No. 241047 official report, a U.S. Pat. No. 5828429 number specification, this No. 6023308 specification, the Japanese patent No. 2784615 specification, etc. about the drive of the light emitting device of this invention.

[0070]

The light emitting device of this invention can be used effective in the surface light source of a full color display, a back light, the source of the illumination light, etc., light source arrays, such as a printer, etc., although an application is not limited.

[Example]

[0071]

Although the example of the light emitting device of this invention is explained below, this invention is not limited at all by these examples.

[0072]

(Example 1)

Thickness introduced this base material in the vacuum chamber by 0.5mm, using the glass plate of 2.5cm angle as a base material, and SnO₂ content formed the ITO thin film (thickness of 0.2 micrometers) as a transparent electrode

(anode plate) using the ITO target (indium: tin =95:5 (mole ratio)) which is 10 mass % by DC magnetron sputtering (conditions: base material temperature of 250 degrees C, 1x10 to 3 Pa oxygen pressure). The surface electrical resistance of an ITO thin film was 10ohm/**.

Next, the substrate in which the transparent electrode was formed was put into the wash fountain, and after carrying out IPA washing, UV-ozonization was performed to this for 30 minutes.

[0073]

N, N'-dinaphthyl-N, and 0.03 micrometers of N'-diphenyl benzoIJIN were prepared by 1nm/second in rate with the vacuum deposition method as an electron hole transportation layer on this anode plate.

Besides, vapor codeposition was carried out so that it might become evaporation rates 1/5 about 4, 4'-N, and an N'-dicarbazole biphenyl as the tris (2-phenyl pyridyl) iridium which is a phosphorescence luminescence compound, and a host compound, and tris (2-phenyl pyridyl) iridium concentration produced the 0.006 micrometers of the 1st luminous layer of 20 mass %.

Furthermore on it, as the tris (2-phenyl pyridyl) iridium which is a phosphorescence luminescence compound, and a host compound 4, 4'-N, and an N'-dicarbazole biphenyl are used. Tris (2-phenyl pyridyl) iridium concentration 0.006 micrometers and the 3rd luminous layer were prepared for the 2nd luminous layer, and 0.006 micrometers and the 0.006 micrometers of the 5th luminous layer were prepared for 0.006 micrometers and the 4th luminous layer so that it might become 15 mass %, 10 mass %, 5 mass %, and 0.01 mass % by the 2nd - the 5th luminous layer, respectively.

[0074]

further -- a it top -- as an electronic transportation ingredient -- 2, 2', and 2'' - (1, 3, 5-benzene Trier) tris [the 3-(2-methylphenyl)-3H-[4 and 5-imidazo b] pyridine] (compound 27) was vapor-deposited by 1nm/second in rate, and the 0.050-micrometer electronic transportation layer was prepared.

Furthermore, on this, LiF was vapor-deposited by 1nm/second in rate as an electronic injection layer, and the 0.002-micrometer electronic injection layer was formed.

[0075]

Furthermore, the mask (mask with which luminescence area is set to 5mmx5mm) which carried out patterning was installed on this electronic injection layer, 0.25 micrometers of aluminum were vapor-deposited within vacuum evaporatio equipment, and the back plate (cathode) was formed.

[0076]

From the transparent electrode (it functions as an anode plate), and the back plate, the lead wire of aluminum was connected, respectively and the luminescence layered product was formed.

The luminescence layered product obtained here was put in in the glove compartment permuted with nitrogen gas. 10mg of calcium-oxide powder as water adsorbent was put into closure covering made from stainless steel which prepared the crevice inside all over the glove compartment, and it fixed with adhesive tape. It closed using ultraviolet curing mold adhesives (the product made from the Nagase tiba, XNR5516HV) as this closure covering and adhesives. The light emitting device of an example 1 was created by the above.

[0077]

The following approaches estimated using this light emitting device.

Impress direct current voltage to a light emitting device, it was made to emit light using the source major unit 2400 mold made from Oriental TEKUNIKA, and the early luminescence engine performance was measured. The electrical potential difference when Lmax and Lmax are obtained in the highest brightness at that time was set to Vmax. It was shown in Table 1 further 2000 Cd/m, having used luminous efficiency at 2:00 as external quantum efficiency (eta 2000).

Moreover, drive durability test was carried out by initial brightness 2000 Cd/m2, and the test result was shown in Table 1 by making into half line (T1/2) time amount from which brightness became half.

[0078]

(Example 2)

In the example 1, except making the vacuum evaporatio conditions of a luminous layer into the following conditions, the component was created by the same approach as an example 1, and the same approach as an example 1 estimated.

The test result was shown in Table 1.

[0079]

<The vacuum evaporatio conditions of a luminous layer>

As the tris (2-phenyl pyridyl) iridium which is a phosphorescence luminescence compound, and a host compound,

vapor codeposition of 4, 4'-N, and the N'-dicarbazole biphenyl was carried out so that it might become evaporation rates 1/10, and tris (2-phenyl pyridyl) iridium concentration produced the 0.006 micrometers of the 1st luminous layer of 10 mass %.

Furthermore on it, as the tris (2-phenyl pyridyl) iridium which is a phosphorescence luminescence compound, and a host compound 4, 4'-N, and an N'-dicarbazole biphenyl are used. Tris (2-phenyl pyridyl) iridium concentration 0.006 micrometers and the 3rd luminous layer were prepared for the 2nd luminous layer, and 0.006 micrometers and the 0.006 micrometers of the 5th luminous layer were prepared for 0.006 micrometers and the 4th luminous layer so that it might become 8 mass %, 6 mass %, 4 mass %, and 1 mass % by the 2nd - the 5th luminous layer, respectively.

[0080]

(Example 3)

In the example 1, except making the vacuum evaporatio conditions of a luminous layer into the following conditions, the component was created by the same approach as an example 1, and the same approach as an example 1 estimated.

The test result was shown in Table 1.

[0081]

<The vacuum evaporatio conditions of a luminous layer>

As the tris (2-phenyl pyridyl) iridium which is a phosphorescence luminescence compound, and a host compound, vapor codeposition of 4, 4'-N, and the N'-dicarbazole biphenyl was carried out so that it might become evaporation rates 1/10, and tris (2-phenyl pyridyl) iridium concentration produced the 0.01 micrometers of the 1st luminous layer of 10 mass %.

Furthermore, using 4, 4'-N, and an N'-dicarbazole biphenyl as the tris (2-phenyl pyridyl) iridium which is a phosphorescence luminescence compound, and a host compound, on it, 0.01 micrometers and the 0.01 micrometers of the 3rd luminous layer were prepared for the 2nd luminous layer so that tris (2-phenyl pyridyl) iridium concentration might become 5 mass % and 0.01 mass % by the 2-3rd luminous layers, respectively.

[0082]

(Example 4)

In the example 1, the luminous layer created by the same approach as an example 1. Then, bis(2-methyl-8-quinolinolato N1, O8) aluminum (Balq) was vapor-deposited by 1nm/second in rate as an electron hole block ingredient (1 and 1'-biphenyl) (-4-ORUATO), and the 0.010-micrometer electron hole block transportation layer was prepared.

Furthermore, on it, tris (8-hydroxyquinolate) aluminum was vapor-deposited by 1nm/second in rate as an electronic transportation ingredient, and the 0.040-micrometer electronic transportation layer was prepared.

Furthermore, on this, LiF was vapor-deposited by 1nm/second in rate as an electronic injection layer, and the 0.002-micrometer electronic injection layer was formed.

[0083]

Furthermore, the mask (mask with which luminescence area is set to 5mmx5mm) which carried out patterning was installed on this electronic injection layer, 0.25 micrometers of aluminum were vapor-deposited within vacuum evaporatio equipment, and the back plate was formed.

[0084]

From an anode plate and cathode, the lead wire of aluminum was connected, respectively and the luminescence layered product was formed.

The luminescence layered product obtained here was put in in the glove compartment permuted with nitrogen gas. 10mg of calcium-oxide powder as water adsorbent was put into closure covering made from stainless steel which prepared the crevice inside all over said glove compartment, and it fixed with adhesive tape. It closed using ultraviolet curing mold adhesives (the product made from the Nagase tiba, XNR5516HV) as this closure covering and adhesives. The light emitting device of an example 4 was created by the above.

Then, the same approach as an example 1 estimated. The result was shown in Table 1.

[0085]

(Example 1 of a comparison)

In the example 1, except making the vacuum evaporatio conditions of a luminous layer into the following conditions, the component was created by the same approach as an example 1, and the same approach as an example 1 estimated.

The test result was shown in Table 1.

[0086]

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<The vacuum evaporation conditions of a luminous layer>

As the tris (2-phenyl pyridyl) iridium which is a phosphorescence luminescence compound, and a host compound, vapor codeposition of 4, 4'-N, and the N'-dicarbazole biphenyl was carried out so that it might become evaporation rates 1/20, and tris (2-phenyl pyridyl) iridium concentration produced 0.03 micrometers of single luminous layers of 5 mass %.

[0087]

[Table 1]

	L_{\max} (Cd/m ²)	V_{\max} (V)	η_{2000} (%)	$T_{1/2}$ (H)
実施例 1	87000	12	13.7	8200
実施例 2	98000	11	14.5	9500
実施例 3	77000	12	12.5	6500
実施例 4	63000	11	12.1	5600
比較例 1	78000	13	4.2	1200

[0088]

The result shown in Table 1 shows that the light emitting device of this invention to which the concentration of the phosphorescence luminescence compound of a luminous layer becomes high one by one towards a luminous layer at an anode plate side from the luminous layer by the side of cathode is remarkably superior to the comparison light emitting device of the example 1 of a comparison which the concentration of a phosphorescence luminescence compound becomes from a uniform single luminous layer in luminous efficiency and endurance.

[Translation done.]